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Indian Standard
SPECIFICATION FOR ELECTRONIC WEIGHING SYSTEMS

PART II METHODS OF MEASUREMENTS

UDC 621·267·7 — 838 : 621·317·3

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SPECIFICATION FOR ELECTRONIC WEIGHING SYSTEMS

PART II METHODS OF MEASUREMENTS

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Indian Standard

SPECIFICATION FOR ELECTRONIC WEIGHING SYSTEMS

PART II METHODS OF MEASUREMENTS

0. FOREWORD

0.1 This Indian Standard (Part II) was adopted by the Indian Standards Institution on 26 December 1979, after the draft finalized by the Electronic Measuring Equipment Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The specification for electronic weighing systems is being prepared in following four parts:

Part I Terms and definitions
Part II Methods of measurements
Part III Requirements
Part IV Code of practice for installation and use

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part II) prescribes the conditions and detailed procedures for the measurement of performance characteristics of the load sensing device and its associated instrumentation, used in electronic weighing systems.

2. TERMINOLOGY

2.0 For the purpose of this standard, terms and definitions given in IS : 9281 (Part I)-1978† shall apply.

---

*Rules for rounding off numerical values (*revised*).

†Specification for electronic weighing systems: Part I Terms and definitions.

3. PERFORMANCE CHARACTERISTICS

3.1 The following performance characteristics are considered essential for measurement, while standardizing the electronic weighing systems;

a) Accuracy,
b) Non-linearity,
c) Hysteresis,
d) Sensitivity,
e) Rated output,
f) Overload,
g) Effects of loading,
h) Creep,
j) Creep recovery,
k) Fatigue life,
m) Repeatability,
n) Resolution,
p) Temperature effects,
q) Drift,
r) Zero shift,
s) Insulation resistance,
t) Thermal impedance,
u) Response time, and
v) Sealing.

4. GENERAL CONDITIONS FOR MEASUREMENTS

4.1 Unless otherwise specified, all measurements shall be carried out under the following standard atmospheric conditions:

Temperature	Between 15 and 35°C
Relative humidity	Between 45 and 75 percent
Atmospheric pressure	Between 86 and 106 kPa

4.1.1 Where the conditions mentioned above have a significant influence, these shall be kept substantially constant during the measurements.

4.2 For specific measurements which are considered dependent on atmospheric conditions, the measurements shall be conducted, and in case of doubt, repeated at a temperature of 25 ± 1°C and relative humidity of 65 ± 2 percent.

4.3 The parameters, which may influence the performance of electronic weighing systems are given in Appendix A.

5. ACCURACY

5.1 A typical test setup for the calibration of the load cell and the system is given in Fig. 1. Note the output at no load conditions. Apply axially standard loads, 30 percent, 70 percent and 100 percent of the rated load specified and observe the output voltage either across the load cell or at the output of the signal conditioner. Draw the best fit curve joining these four points. The accuracy is then interpolated.

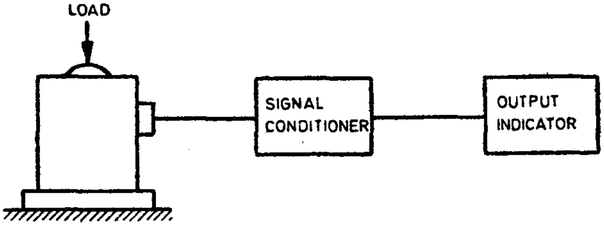


FIG. 1 SETUP FOR ACCURACY

6. NON-LINEARITY

6.1 The procedure as given in **5.1** is repeated with the loading increased from zero to rated load in equal increments without overloading (overshooting) at each point. The corresponding reading, immediately after the load has stabilized, is taken in each case. The curve joining the various points is drawn. The maximum deviation of the curve from the straight-line joining the end points (Terminal linearity) is then interpoluted as the non-linearity factor (*see* Fig. 2).

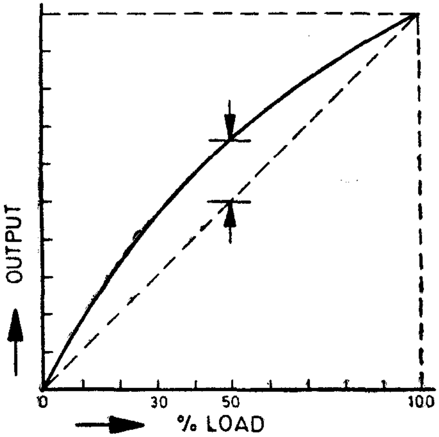


FIG. 2 SETUP FOR NON-LINEARITY

7. HYSTERESIS

7.1 The procedure as given in **5.1** is repeated with the load applied in ten equal steps, first increased in the ascending order from zero to full scale and then decreased in the descending order back to zero. Corresponding readings of the output at the various loads are taken and a graph showing output *versus* load is drawn. The maximum deviation (nominally occurring at 50% load) from the line joining the end points shall give the hysteresis value (*see* Fig. 3).

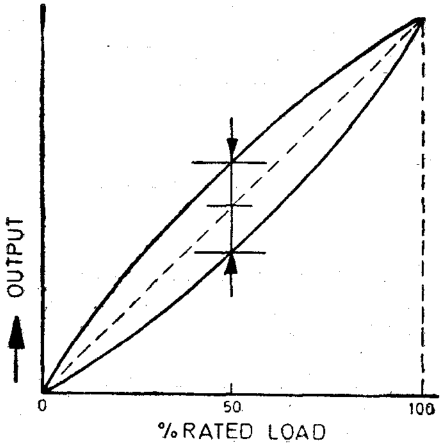


FIG. 3 SETUP FOR HYSTERESIS

8. SENSITIVITY

8.1 Apply the rated load in the manner specified by the manufacturer and measure the output with a standard voltmeter. Sensitivity is then computed as the magnitude of output per volt excitation per full scale rated load.

9. OVERLOAD

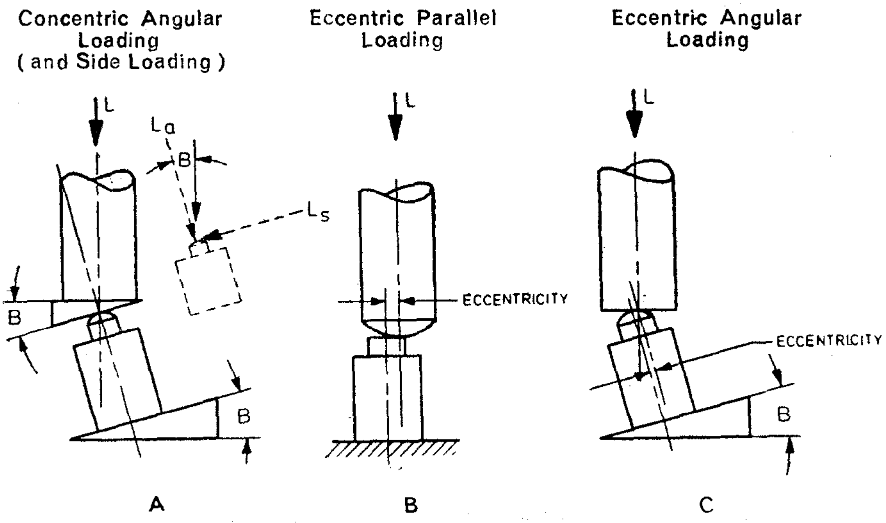
9.1 Note the zero reading at ' No load ' condition and apply load in an increasing manner up to the specified overload value. Retain this condition for a period of 30 seconds and then release back to the ' No load ' condition. Check the zero reading now and record the deviations, after a creep recovery period of 30 minutes. The zero position shall not get shifted beyond the allowable limit, specified by the manufacturer.

10. CROSS SENSITIVITY

10.1 Three types of measurements are carried out and errors computed as given in Fig. 4:

a) Concentric angular load,
b) Eccentric parallel load, and
c) Eccentric angular load.

10.2 The load cell is checked for its cross sensitivity by applying load as described in **6.1** and recording the outputs, at rated load, but with the experimental setup as given in Fig. 5. The deviations obtained in each case is computed as a percentage of rated output.


Concentric Angular Loading (and Side Loading)

Eccentric Parallel Loading

Eccentric Angular Loading

A $\text{Error} = \dfrac{e_a - e_1/\text{Cos B}}{e_a} \times 100$ (% Rated output)

B $\text{Error} = \dfrac{e_a - e_2}{e_a} \times 100$ (% Rated output)

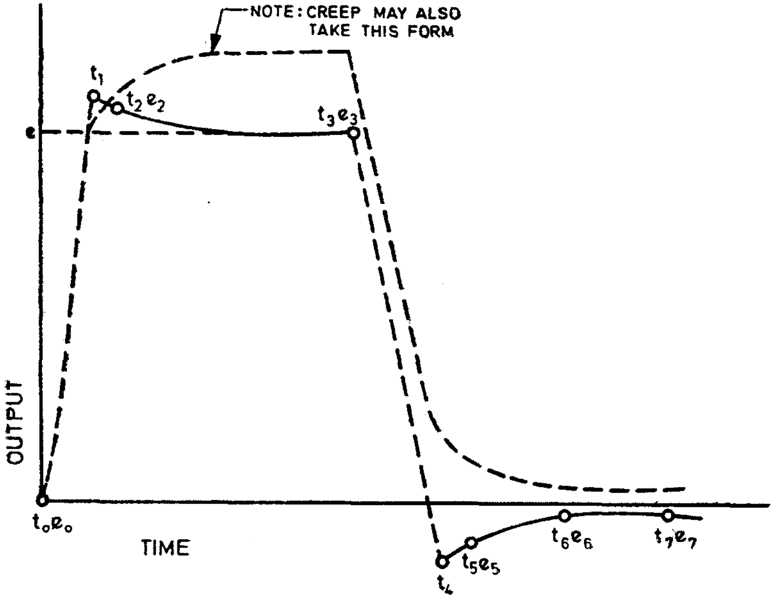
C $\text{Error} = \dfrac{e_a - e_3/\text{Cos B}}{e_a} \times 100$ (% Rated output)

e_a = Rated output at rated axial loading
e_1, e_2, e_3 = Output under any unfavourable rated loading conditions
L = Load
L_a = Axial load
L_s = Side load

FIG. 4 EFFECTS OF LOADING

11. CREEP

11.1 Apply the full rated load gradually without overshooting and read the output immediately after the load has been applied, after 5 seconds and 10 seconds, and at intervals of 10 seconds up to 30 seconds, at intervals of 30 seconds up to 3 minutes (short term creep), and at intervals of 2 minutes up to 30 minutes (long term creep). The output values obtained, at all these timings are then plotted as output *versus* time. The creep rate is then computed from this curve as shown in Fig. 5.



t_1-t_0 = Load application. Should be carefully considered in comparative creep measurement.
t_2-t_1 = Should be as short as possible. (Suggested 5 – 10 sec.)
t_3-t_2 = Creep measurement period. Suggested 3 min for short term and 30 min for long term.
$\frac{e_3-e_2}{e} \times 100$ = Creep in percent rated output.
t_4-t_3 = Load release period. (Should equal t_1-t_0.)
t_5-t_4 = Should be as short as possible. (Suggested 5 – 10 sec.)
t_6-t_5 = Creep recovery period. Suggested 3 min for short term and 30 min for long term.
$\frac{e_5-e_6}{e} \times 100$ = Creep recovery in % rated output.
t_7 = Time at which zero return is measured.
$\frac{e_7-e_0}{e} \times 100$ = Zero return in % rated output.

FIG. 5 CREEP AND CREEP RECOVERY

12. CREEP RECOVERY

12.1 In the measurements as given in **11.1** remove the full rated load as rapidly as possible and take readings of the output at zero load after 5 seconds, and 10 seconds, and at intervals of 10 seconds up to 30 seconds, at intervals of 20 seconds up to 3 minutes, and at intervals of 2 minutes up to 30 minutes. The creep recovery is then computed from the curve shown in Fig. 5.

13. FATIGUE CAPACITY

13.1 Apply load to the load cell up to 120 percent of the rated load and cycle loading from this load to zero load for at least 100 cycles of operation. Check the zero and sensitivity before and after this cycling procedure and assess the degradation, if any, in the electrical performance. Any departure from the original value is computed.

14. REPEATABILITY

14.1 Keep the load cell at standard temperature, apply the rated load and note the output. Release the load to 'No load' condition and subject the load cell to a temperature cycling from −10C to +60°C keeping the cell for at least 30 minutes earth, at the lowest and highest temperature (maintained constant for soaking). Bring it back to the standard temperature from 60°C and apply the rated load again. Note the reading. Record the deviations obtained at 'No load' and 'Rated load' conditions. The deviation is expressed in terms 'full scale rated load'.

15. RESOLUTION

15.1 Apply a nominal load (say 50 percent of rated load). Change this load by small increments. The smallest load that would give a detectable and measurable value in the output is the resolution of the whole system.

16. SPAN

16.1 This experiment gives the range over which the load cell performance is maintained within the specifications. Apply minimum measurable load as specified by the manufacturer, note the output and check the sensitivity. Add now 1% of rated load and check the sensitivity again. These two values shall remain the same, if it is within the span.

Apply 100% of rated load and check the sensitivity. Repeat the experiment by removing 1% of rated value and compute the sensitivity again. These two values shall also remain the same.

17. DRIFT

17.1 Drift Due to Time — The drift of the electronic weighing system is measured at, ' No load ' condition. Note the drift of the zero value, without any load, after the initial 30 minutes warm up period, for a period of 6 hours, in steps of 30 minutes. Note the reading at every 30 minutes. Any change in value is computed in terms of full scale.

17.2 Temperature Drift — The drift due to temperature is measured at ' No load ', as well as ' Rated load ' conditions.

Observe the reading at ' No load ' condition. Subject the load cell from 0°C to 50°C, keeping the temperature constant for at least 10 minutes at each level. Note the readings of the ' zero ' at every point. Compute the drift due to temperature.

Repeat the above experiment, under the rated load condition also.

Any change in reading at the ' No load ' and ' Rated load ' conditions, expressed in terms of Full Scale gives the temperature drift of the device.

17.3 Drift Due to Humidity — Repeat experiment as above in **17.2** with the load cell kept at standard temperature and at standard humidity (40% RH) as well as at humidity of 90% RH. Note the drift in output at a ' No load ' and full load under these two conditions.

18. INSULATION RESISTANCE

18.1 Check the insulation between electrical leads of the load cell all tied together and the body of load cell, at 50 V dc excitation. The value shall be at least 1 000 MΩ.

NOTE — The experiment is to be carried out at standard conditions of temperature, humidity and pressure.

19. THERMAL IMPEDANCE (EXCITATION AND SIGNAL)

19.1 The impedance/resistance between the excitation loads and the signal leads of the load cell are measured independently with a standard impedance bridge or resistance meter, with a voltage not exceeding the rated excitation voltage. The value obtained gives the excitation and signal impedance of the cell in ohms.

NOTE 1 — The measurement is carried out without any electrical excitation.

NOTE 2 — The excitation impedance is measured with the output shorted.

NOTE 3 — The signal impedance is measured with the input leads shorted.

20. RESPONSE TIME

20.1 Apply a shock input load to the load cell with a hammer and observe the output, with a time-scale calibrated oscilloscope. The rise time and the response time and natural resonance frequency are computed from the damped oscillation obtained.

21. SEALING

21.1 This test shall be carried out in accordance with IS : 9000 (Part XV)………*.

APPENDIX A

(*Clause* 4.3)

INFLUENCE QUANTITIES

A-1. INFLUENCE QUANTITIES

A-1.0 Following influence quantities are relevant.

A-1.1 Levelling Defects

A-1.1.1 *Uneven Level at No Load* — At no load, the indication on instruments likely to be at uneven level, shall not vary by more than two verification graduations under the influence of a longitudinal or transversal inequality of level equal to two in one thousand.

A-1.1.2 *Uneven Level Under Load* — The indication of instruments likely to be at uneven levels, shall not vary by more than one verification graduation under the influence of a longitudinal or transversal inequality of level equal to, two in one thousand, the variation being observed at the capacity of self-indication or printing and at the maximum capacity.

A-1.1.3 *Test Conditions* — For controlling the preceding requirements, the instruments shall be adjusted to zero at no load:

a) in their reference position of adjustment, before making the level uneven; and

b) in the uneven position, before putting on the load.

---

*Basic environmental testing procedures for electronic and electrical item: Part XV Sealing tests (*under preparation*).

A-1.2 Temperature

A-1.2.1 *Limits of Temperature*

a) *Regulation limits* — If no particular working temperature is specified in the operative instructions of an instrument, it shall satisfy the conditions of maximum permissible errors and variations allowed between test load results and metrological qualities in the following range of temperature −10C to +40°C.

b) *Special limits* — Instruments for which particular range of working temperatures are mentioned in the operating instruction, shall satisfy, within those limits, the conditions of maximum permissible errors and variations, allowed between test load results and metrological qualities.

The intervals between these ranges shall at least be equal to 30°C.

A-1.2.2 *Stability of Indication at No Load (Zero Indication) as a Function of Temperature* — The instruments shall be such that their indication at no load does not vary by more than one verification graduation for a difference of 5°C in ambient temperature.

A-1.2.3 *Temperature for an Instrument* — The control of an instrument shall be carried out at a constant ambient temperature within the limits fixed for its operation.

That temperature is considered practically constant which does not vary by more than 5°C per hour.

A-1.3 Electric Power Supply — Instruments working on electric energy shall satisfy the conditions of maximum permissible errors and variations allowed between test load results and metrological qualities within the limits of variation of the electric power supply between ±10 percent of nominal voltage and ±2 percent of nominal frequency.

A-1.4 Other Influence Factors and Restraints Resulting from Normal Requirements of Use — The instruments shall satisfy the conditions of maximum permissible errors and variations allowed between test load results and metrological qualities even when either influence factors or restraints intervene such as:

a) Magnetic fields,
b) Electric fields,
c) Vibrations,
d) Atmospheric conditions, and
e) Mechanical constraints and restrictions.

A-1.5 The instruments shall either be properly corrected against these influences or shall be protected against them.